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Assessing Status of Utilization of Agrochemicals in Fish Farming: A Study from Rural Bangladesh

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Abstract

The current study was piloted to assess the status of utilization of agrochemicals in fish farming by the farmers in Trishal upazila (sub-district), Mymensingh District, Bangladesh. Data were collected for a period of five months during January to May 2019 through individual interviews from a sample of 80 fish farmers. Descriptive statistics: percentage, mean and standard deviation were used to analyse the data. The findings revealed that most severe fish diseases in the study area are epizootic ulcerative syndrome in Pangus (*Pangasianolan hypophthalmus*), Thai koi (*Anabas testudineus*), Shing (*Heteropneustes fossilis*), and black spot in Sarpunti (*Barbodes sarana*). To eliminate diseases in fish farming, 21 agrochemicals were employed (2 water quality management chemicals, 3 disinfectants, 3 antibiotics, 4 growth promoters, 3 oxygen suppliers, 2 gas reducers, and 4 disease treatment chemicals). The Department of Fisheries (DOF) and other relevant organizations should take proper attempts to enhance fish farmers' knowledge and capability in disease diagnosis and agrochemicals application for profitable fish farming.

1. Introduction

Bangladesh, with favorable climate and availability of natural fish feed, is considered one of the most suitable regions for fish farming in the world (Shamsuzzaman et al., 2020; Sheheli et al., 2019). In Fiscal Year (FY) 2017-2018, Bangladesh was recognized as one of the world's leading fish producing countries with a total production of 42.77 lakh metric tons (MT) (DOF, 2018). Inland open water capture, inland open water culture, and marine fisheries are all abundant across the country (FRSS, 2017; Shamsuzzaman et al., 2017). Globally, Bangladesh secured 3rd position in inland open water capture fish production and 5th in aquaculture production (FAO, 2018). There are three types of aquaculture practices in Bangladesh such as inland capture, inland culture, and marine fisheries (Das et al., 2020; DOF, 2017).

Fish farming, in national economy of Bangladesh (FRSS, 2017), contributes approximately 3.65% to the national gross domestic product (GDP) and 23.81% to the agricultural GDP (DOF, 2018). Along with financial profits, fish farming plays a vital role in food security as a major source of animal protein in Bangladesh (DOF, 2017; Khan et al., 2018; Ullah et al., 2020, Khanum et al., 2022). Globally, about 880 million people rely on fisheries sector for their livelihoods (Allison et al., 2013), while this number in Bangladesh is around 18 million (Shamsuzzaman et al., 2017). The fisheries sector, through earning foreign currency and providing employment opportunities, improves the socioeconomic condition of a large number of people in Bangladesh (Islam et al., 2014; Fagun et al., 2020). However, a high rate of fish production is essential to feed the growing population in Bangladesh (Hasan et al., 2010).

Timely utilization of agrochemicals is urgent to make fish farming profitable (Rahman et al., 2019; Demi and Sicchia, 2021). In Bangladesh, agrochemicals are utilized in an increasing trend to control, destroy, mitigate, prevent or repel pests in aquatic animal health management (Haque et al., 2019; Alam and Rashid, 2014). The farmers utilize several types of agrochemicals for pond preparation, soil and water treatment, feed preparation, management of

reproduction, raising growth, processing, and finally value addition of the fishes for sale (Rahman et al., 2019; Haque et al., 2019; Chowdhury et al., 2012). Lime, timsen, captor, aquaboost, oxylife, ammonil, phostoxin tablet, salt, rotenone, sumithion, formalin, different fertilizers, etc. are frequently utilized agrochemicals in aquaculture (Shamsuzzaman et al., 2012; Faruk et al., 2008; Ullah et al., 2020). Agrochemicals used in fish farming can be classified according to their intended application i.e. antibiotics, growth promoter, water quality management, disinfectant, oxygen supplier, insecticides, etc. (Ullah et al., 2020; Ahmed et al., 2014).

The fish farmers should be aware of using appropriate dosage of agrochemicals to avoid water contamination as well as environmental degradation (Haque et al., 2019; Chowdhury et al., 2012). Residues of agrochemicals may build up in fish species, posing a health risk to consumers (Ali et al., 2018). As a result, understanding the dosage of agrochemicals used by the fish farmers is essential for fish health management. In consideration of the above, the current research was performed to assess the status of utilization of agrochemicals in fish farming by the farmers of Bangladesh. The specific objectives of the study were to define the socioeconomic features of the fish farmers; to find out diseases of fish; and to explore the status of utilization of agrochemicals in fish farming.

2. Materials and Methods

The present investigation was carried out based on a field survey where data were collected from the fish farmers.

2.1 Study location

The study was piloted in Trishal sub-district (also known as upazila) of Mymensingh District, Bangladesh. The sub-district occupies an area of 338.98 km^2 and located in between 24°28' and 24°41' north latitudes and 90°18' and 90°32' east longitudes (Bangladpedia, 2021). Mymensingh District is prominent for fish production (Ahmed et al., 2011) where a large number of farmers involved with fish farming (Mithun et al., 2020; Das et al., 2020) through using aqua drugs and agrochemicals (Haque et al., 2019).

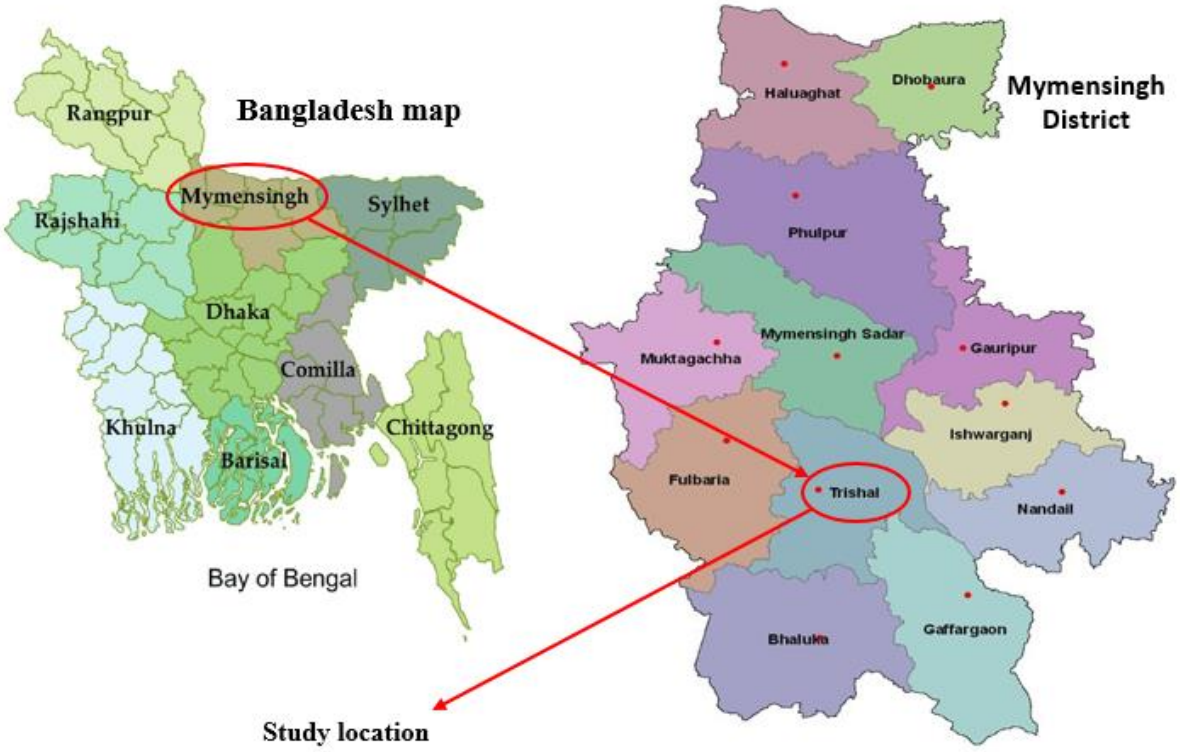

Figure 1. Map showing the study location in Bangladesh

2.2 Population and sampling

The fish farmers of Trishal sub-district were the population of the investigation. According to the list collected from the upazila fisheries office, the field level government headquarters for fisheries extension and advisory services, there were a total of 800 fish farmers in the study area. A sample size of 80 was considered for investigation using Yamane's formula (1967), with 95% confidence interval and 10% level of accuracy (Equation 1).

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

Where, *N*=total fish farmers in the study location, *n*=sample size, and *e*=level of accuracy.

2.3 Data collection and analysis

To obtain information from fish farmers, a face-to-face interview was conducted using a structured interview schedule. The interview schedule consisted of two sections. The first section was regarding socioeconomic features of the respondents i.e. fish farmers' age, level of education, family size, occupation, farm size, training experience, annual income, credit received, and knowledge on fish farming. The second section sought data on diseases of fish and status of utilization of agrochemicals in fish farming for disease management by the fish farmers. The interview schedule was revised and modified based on the suggestions of the experts including academia, researchers and extension service providers. Data were collected from the fish farmers during January to May 2019. The collected data were coded and analyzed using Statistical Package for Social Science (SPSS) var. 20 and Microsoft Excel ver. 13. Tables and figures were utilized to show data. The socioeconomic features were presented in the form of descriptive statistics, such as percentage, mean and standard deviation. Descriptive statistics can help to clarify the socioeconomic features of the respondents in a study (Fraenkel *et al.*, 2012). On the other hand, the parameters such as active ingredients, purpose, and dosage were employed to explore the status of utilization of agrochemicals in fish farming.

3. Results and Discussion

3.1 Socioeconomic features of the fish farmer

Table 1 presents the socioeconomic features of the fish farmers. The findings exposed that about half of the fish farmers (53%) were middle aged followed by young (40%). Young farmers supply more physical labor to ensure high rate of fish production (Fagun et al., 2020).

Majority of the respondents had primary (24%) to secondary (58%) education in the study area. Education acts as a crucial factor that affects fish culture management activities by the fish farmers (Das et al., 2020). Farmers with more years of education have greater access to knowledge and analytical skills, letting them to apply agrochemicals more effectively (Hoque et al., 2022). More than half of the fish farmers (52%) belonged to medium sized family and maximum of them (88%) were involved in fish farming as their main occupation. Fish farmers consider their family members as an important source of labor for them (Onemolease and Oriakhi, 2011).

Most of the respondents (55%) had medium sized farm followed by small (38%) and more than half of them (58%) had medium income annually (Table 1). Rahman et al. (2012) observed that family income is the significant economic factor affecting fish farming. The results revealed that more than three-fourth of the fish farmers (84%) received 1 to 3 days training on fish farming especially on using agrochemicals. Training plays a key role in increasing capacity of the farmers to manage their farms successfully (Mithun et al., 2020). Majority of the respondents (70%) received credit from different credit organizations to perform fish farming activities successfully. Most of the fish farmers (54%) had medium knowledge followed by low (26%) on utilizing agrochemicals for fish culture in the study area. The ability of the fish farmers to maintain a farm basically depends on their knowledge (Hoque et al., 2021).

3.2 Diseases of fish

Fish production is highly dependent on the proper application of chemicals and the maintenance of water quality (Ullah et al., 2020). Disease outbreaks are particularly common in aquaculture systems with high stocking density and irregular feed delivery. A variety of diseases were identified in the study region, including epizootic ulcerative syndrome (EUS), viral hemorrhage disease (VHS), gill damage, tail rot, skin erosion, and black spot. The EUS in Pangus (*Pangasianolan hypophthalmus*), Thai koi (*Anabas testudineus*), Shing (*Heteropneustes fossilis*), and black spot in Sarpunti (*Barbodes sarana*) were found as most severe fish disorders (Figure 2). In Jhenaidah District of Bangladesh, Rahman et al. (2019) observed EUS, skin lesion, gill damage, tail and fin rot as fish diseases. According to Alam and Rashid (2014), in Shatkhira city of Bangladesh, there were a variety of disorders affecting Rui (*Labeo rohita*), Sarpunti (*Barbodes sarana*), Catla (*Catla catla*), Silver carp (*Hypophthalmicthys molitrix*), Tilapia (*Oreochromis nilotika*), Golda (*Macrobachium rosenbergi*), Bagda (*Penaeus monodon*), and Mrigal (*Cirrhinus cirrhosus*), including bacterial infections, EUS, ichthyophthiriasis, argulosis and enlarged abdomen and white spot diseases.

Table 1. Socioeconomic profile of the respondents (n=80)

Socioeconomic features	Percentage	Mean	SD*

Age (years)			
Young (up to 35)	40		
Middle age (36-55)	53	39	7.75
Old (above 55)	7		
Level of education (years)			
Can't sign (0)	4		
Sign only (0.5)	7		
Primary level (1-5)	24	7	3.36
Secondary level (6-10)	58		
HSC (12)	5		
Degree (14)	2		
Family size (numbers)			
Small (up to 4)	38		
Medium (5-7)	52	5	1.56
Large (above 7)	10		
Occupation (score)			
Main (1)	88	2	0.33
Subsidiary (2)	12		
Farm size (ha)			
Small (up to 1)	38		
Medium (1.1-3)	55	1	0.61
Large (above 3)	7		
Annual income ('000' BDT)			
low (up to 35)	24		
Medium (36-80)	58	7	5.01
High (above 80)	18		
Training experience (days)			
No training (0)	16	2.73	5.39
Training received (1-3)	84		
Credit received ('000' BDT)			
No receiver (0)	30	7	5.39
Receiver (1)	70		
Knowledge on fish farming (score)			
Low (up to 11)	26		
Medium (12-23)	54	8	2.42
High (above 23)	20		

SD* = Standard Deviation; ha = hectare; BDT = Bangladeshi Taka

3.3 Agrochemicals utilized by the farmers in fish farming

Table 2 lists 21 agrochemicals used by the farmers in fish farming (2 water quality management chemicals, 3 disinfectants, 3 antibiotics, 4 growth promoters, 3 oxygen suppliers, 2 gas reducers, and 4 disease treatment chemicals) along with their active ingredients, purposes and prescribed dosage.

3.3.1 Chemicals for water quality improvement

The control of water quality is essential for growth, development, breeding, longevity, and feed intake of the fish species. For water quality improvement, Lime and Mega Zeo Bio were used in the study area (Table 2). Rahman et al. (2019) stated that Lime, Geotox, JV Zeolite, Mega Zeo Bio and Aquakleen are used for water quality management.

3.3.2 Disinfectants

The fish farmers used a wide variety of disinfectants such as Virex, Timsen and Virusnip in freshwater aquaculture (Table 2). The fish farmers of Jhenaidah district in Bangladesh used Timsen, Polgard plus, Formalin, Bleaching Powder, EDTA and Eraprim vet as disinfectants (Rahman et al., 2019).

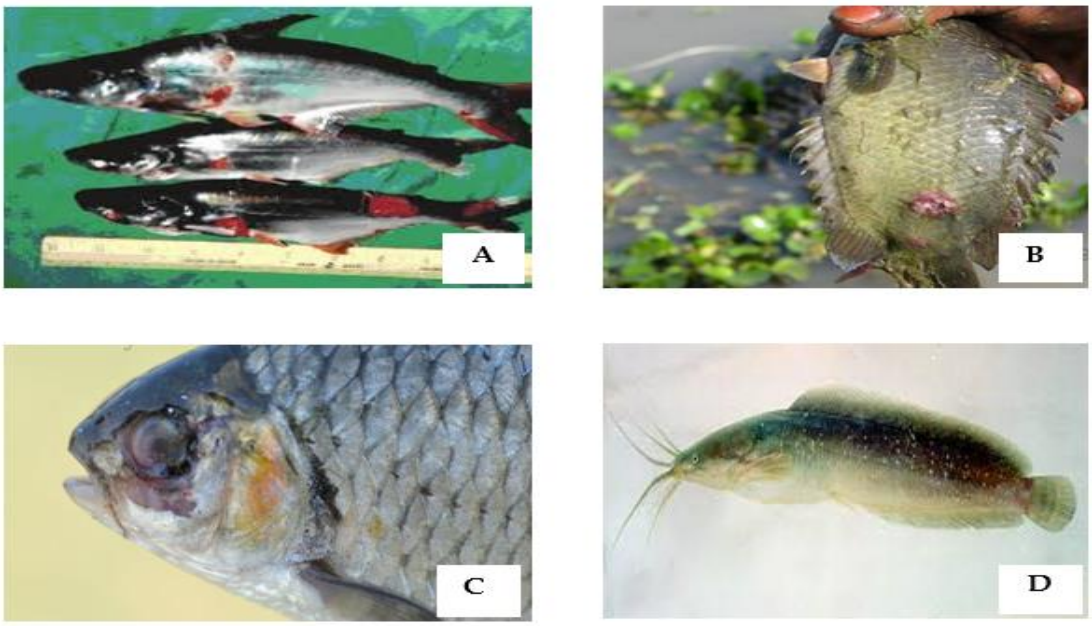

Figure 2. Various diseases in fish A) EUS in *Pangasianolan hypophthalmus*, B) EUS in *Anabus testudineus*, C) EUS in *Barbodes sarana*, D) Black spot in *Heteropneustes fossilis*

3.3.3 Antibiotics

The antibiotics are basically effective against bacterial infection. Captor, Renamycin and Erocot were used as antibiotics by the fish farmers in the study area (Table 2). According to Adhikary et al. (2018) and Biswas et al. (2018), antibiotics such as Oxysentin, Renamycine, Renamox, and Orgamycine are commonly utilized for fish production. Renamycine, Bactitab, Chlorstechlin, Cotrim- Vet, and Orgacycline are utilized as antibiotics in the coastal region of Bangladesh (Sarkar et al., 2014).

3.3.4 Growth promoters

To increase fish production, Aqua Boost, Aqua Gel, Megavit Aqua and Rena Fish were used as growth promoters by the farmers (Table 2). According to Faruk et al. (2008) and Haque et al. (2019), Aquamin, Aqua Boost, Grow fast, Catamin, Aqua Savor, Megavit Aqua, Vitamix and Grow max are used as growth promoter in Bangladesh.

3.3.5 Oxygen suppliers

To boost the oxygen level in the aquatic environment, most of the fish growers utilize oxygen generators. The accessible agrochemicals in the research region for increasing oxygen concentration were Oxygold, Biocare and Oxylife (Table 2). The researchers Rahman et al. (2019) and Haque et al. (2019) observed that to increase dissolve oxygen concentration, the fish growers utilize Oxylife, Oxypol Tablet, Oxygold, Oxyflow, Oxyren, Gasonex and Biocare.

3.3.6 Gas reducers

Gas reducers are essential compounds for removing hazardous gases from water bodies (NH_3, H_2S, etc.). In the research area, chemicals such as Biopond and Ammonil were employed as gas reducers. (Table 2). The fish farmers of Jhenaidah district in Bangladesh utilized Gastrap, Ammonil and Biopond as gas reducer (Rahman et al., 2019).

Table 2. Agrochemicals used by the fish farmers

Agrochemicals	Active ingredients	Purpose	Dosage
Chemicals for water quality improvement			
Lime	CaO, $Ca(OH)_2$, CaCO3	To enhance biological activity, decomposition, and maintain pH	0.6-1.2kg /decimal
Mega Zeo Bio	SiO_2, $A1_2O_3$, CaO, Fe_2O_3, CaO, MgO, Na_2O	To remove gas and turbidity for maintaining water colour	200gm/decimal
Disinfectants			
Virex	Potassium peroxymono sulfate-50%	To save fish species from destructive virus and bacteria	300-500gm/33 decimal
Timsen	N-alkyl dimethyl benzyl ammonium chloride-40%, Stabilized Urea-60%	To remove microorganisms rapidly	90g/33 decimal (1^{st} dose) 65g/33 decimal (2^{nd} dose)
Virusnip	Potassium peroxymono sulphate-50%, Sodium-dichloro-isocyanurate-5%	Mainly used as antifungal and to control ecto-parasites	600gm/100 decimal
Antibiotics			
Captor	Chloro-tetracycline HCl-45%	To destroy *Aeromonas, Vibrio spp.* etc.	50-70gm/100 kg feed for 7-10 days
Renamycin (sp)	Oxy-tetracycline 200mg	To control gram positive and negative bacteria	50mg/kg fish body for 12 days
Erocot	Erythromycine+Sulphodiazine	To ensure better production increasing immunity	5gm/15kg feed for 4-6 days
Growth promoters			
Aqua Boost	Organic acid, Betaglucan	To maintain good health and enhance immunity of fish species	60gm/kg feed
Aqua Gel	EAA, Fatty acid, minerals, antioxidant enriched	To ensure better consumption by improving the taste of feed	15-20gm/kg feed/day
Megavit Aqua	Vitamin A, Na, P, Ca etc.	To keep good health of fishes	50gm/50Kg feed
Rena Fish	Vit A, B, C, D_3, E, K, Mn, Co, Cu, Fe etc.	To improve health condition of fishes	2-3Kg/ton feed
Oxygen suppliers			
Oxygold	$2Na_2CO_3$. $2H_2O_2$-90%	To produce oxygen	800-1200gm/acre
Bio Care	Sodium lorile ether sulphate	To supply oxygen	90-150ml/100 decimal
Oxylife	Oxygen precursosrs, probiotic and Detoxificant	To remove toxic gases by aerobic decomposition of organic wastages	500gm/acre
Gas reducers			
Biopond	Zeolite, Probiotic	To diminish poisonous gases	4-6kg/1acre
Ammonil	Extract of Yucca plant Micro-encapsulated enzyme	To reduce ammonia and other detrimental gases	250gm/acre
Chemicals for disease treatment			
Sumithion	Sumithion 50ec	To destroy risky copepods and crustacean parasites	0.30-0.60ppm
Phostoxin tablet	Aluminium phosphide	To reduce fish poisoning	4-6 tablets /decimal
Ablaze	Doxycycline-1000mg Colistine sulphate-1000mg	Treatment of lesion of fishes	Prevention-one time /month, Treatment-(1-2) times/day
Methylene blue	$C_{1O}H_{18}ClN_3SH_2O$	To eliminate harmful bacteria and fungus	5ppm

3.3.7 Chemicals for disease treatment

Different chemicals were utilized for disease treatment to increase fish production in the study area. Most of the farmers used Sumithion, Phostoxin tablet, Ablaze and Methylene blue to control fish diseases (Table 2). According to

Chowdhury et al. (2015) and Rahman et al. (2019), Ablaze, Bleaching powder, Sumithion, Formalin, Malathion, Salt and Methylene blue are mostly used agrochemicals for disease treatment by Bangladeshi fish farmers.

4. Conclusion and Recommendation

The present study identified seven types of agrochemicals used in fish farming including water quality management chemicals, disinfectants, antibiotics, growth promoters, oxygen suppliers, gas reducers, and chemicals for disease treatment. Epizootic ulcerative syndrome (EUS), viral hemorrhage disease (VHS), gill damage, tail rot, skin erosion, and black spot were among diseases identified. In the study area, Lime and Mega Zeo Bio were used for water quality improvement. Virex, Timsen and Virusnip were available as disinfectants. Antibiotics such as Captor, Renamycin, and Erocot were utilized. To boost up fish production, Aqua Boost, Aqua Gel, Megavit Aqua and Rena Fish were used as growth promoters. The accessible agrochemicals for increasing oxygen level were Oxygold, Biocare and Oxylife. Biopond and Ammonil were employed as gas reducers. Fish growers mostly used Sumithion, Phostoxin tablet, Ablaze and Methylene blue to control fish diseases. There was a lack of training and knowledge of fish farmers on utilization of agrochemicals. To assure safe use, knowledge and awareness raising programs on negative consequences of agrochemicals may be beneficial. The Department of Fisheries (DOF) and related organizations can conduct a training session prior to using any agrochemicals by the fish farmers. Consequently, respective authority, lawmakers, scientists, and scholars must cooperate to minimize the damaging effect of agrochemicals.

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